

Agricultural Research Institute, Pusa

FIRST REPORT

ON

THE FRUIT EXPERIMENTS AT PUSA

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INTRODUCTORY.

"THERE is perhaps no other country in the world where an orchard judiciously planted would yield better results than in India and make a handsome return to its owner in the course of a few years. An area of ten or twenty acres of land which can be had at a low rate, planted exclusively with the choicer kinds of fruit trees, would, in my opinion, be an inheritance worth having specially in Behar." (*Firminger, Manual of Gardening for India*, 1863.)

Although considerable progress has been made in fruit-growing since the introduction of railways, and extensive gardens are to be met with in various parts of India, for example, at Saharanpur, Bangalore, Nagpur, Bassein in the Konkan, in the Khasia Hills, and in some of the hill valleys in the North-West, yet there are no records of any permanent experiments on the growth and management of fruit trees in the plains such as are to be found in England and the United States. Advantage has, therefore, been taken of the Agricultural Research Institute at Pusa to initiate a series of experiments designed to throw light on the behaviour of Indian fruit trees. It is hoped that as a result of this work facts will be ascertained which can be made use of by those engaged in fruit-growing for profit in India.

The present report, which deals with the first year's work, and which will be followed by others as results of interest accumulate, gives an account of the establishment of the orchard and of the experiments in progress.

Considerable difficulty has been experienced in obtaining the large number of plants required for these experiments, and this fact combined with the pressure of other work has delayed to some extent the issue of the present report. Most of the trees were obtained from the Botanical Gardens, Saharanpur, and Mr. H. M. Leake, Economic Botanist to the United Provinces, rendered much valuable assistance in the selection and raising of the experimental plants.

In drawing up the scheme of the experiments I have carefully considered all the available literature on Indian and temperate fruits and have gone through the reports of the fruit experiments in Europe and North America. My opportunities of studying the growth and cultivation of tropical fruits in the West Indies and my observations and experience of fruit-growing and of fruit experiments in Kent while on the staff of Wye College have been of great assistance to me in this work. In order to learn as much as possible of the methods of fruit culture in India I have visited during the last eighteen months all the important botanical gardens in India where fruit trees are cultivated and have consulted the officers in charge of these establishments who freely placed their knowledge and experience at my disposal.

SOME PRELIMINARY CONSIDERATIONS.

The Site.—The land selected for the experiments comprises an area of nineteen acres with a gentle slope towards the south. There is little or no variation in the character of the soil in any section of the area passing from north to south, but the eastern portions of the area are distinctly more clayey than the western half. The heaviest land is the area under mangos.

Water Drainage.—The water drainage of the area is easy. In ordinary circumstances the natural slope of the land in itself is sufficient to get rid of superfluous rainfall. During the monsoon, however, it sometimes happens that a fall as large as six inches in twenty-four hours is experienced. This necessitates the provision

of the surface drains to carry off the water quickly and to prevent water-logging and excessive rain-wash. These drains lead into a deep trench running east and west on the south of the experimental plot, from which the water escapes by several openings towards the south. In this way the excess rainfall is quickly got rid of, and there is no danger of the lowest portions of the area being temporarily flooded.

Air-drainage.—There is also good atmospheric drainage in the experimental area. This is perhaps a more important factor in temperate regions where the damage done by spring frosts is often very great unless there is good air-drainage. Frosts, however, are not unknown in Behar in January and February, so that we have to consider and, if possible, provide against this circumstance. Cold air always collects and lies in low places, and here the danger of frost is greatest. Sloping land allows the cold air to drain away and it is found that, other things being equal, fruit trees on slopes are never damaged to such an extent as those in hollows or on flat land.

Wind.—In Behar the prevailing winds are usually from the west and east. During the months from March to May, the country is swept with great violence by dry, hot westerly winds accompanied by fine dust. At the end of the cold weather in February, at the break of the monsoon in June and later on in September, high easterly winds are sometimes experienced. In addition to these, sudden and violent north-westerly gales, accompanied by hail, of short duration but often doing great damage to trees, sweep down from the mountains and lower the temperature very considerably. Wind-breaks are, therefore, a necessity in fruit-growing in Behar. On the east and west of the fruit area are belts of trees forming good natural wind-breaks. The western wind-break has been strengthened by planting a row of mango trees just outside the experimental area. The slope of the ground towards the south affords considerable protection from the north-westerly gales and further assistance is provided by a hedge on the north side of the area.

Aspect.—As a rule a southern aspect is the best for fruit trees. In Behar it is an advantage during the winter and spring as a protection from frost and in earliness in flowering. In the hot

weather, however, there is a tendency for the ground to dry up under the intense heat, thereby necessitating a greater expenditure of irrigation water.

Irrigation.—All the trees in the area can be watered artificially if necessary. Two distributing tanks have been provided on the highest points on the northern side of the area which are kept filled at a constant level by pumping water from the river by means of an oil-engine about a quarter of a mile away. Besides the advantage of a supply of water during the first-half of the year, and in the event of a break in the monsoon, irrigation affords a valuable protection from frost during the cold weather. The value of watering is recognised by the cultivators in North-West India and is often practised when frost is feared. The most serious frosts occur when the air is dry. The evaporation of water after irrigation renders the air moister, raises the dew point, and thus protects the trees.

Arrangement of the plots.—The base line of the area is the southern boundary from which the rows run north and south. All the varieties planted for experimental work are represented by one row, except in the litchis where there are three rows of one variety. The plots run in blocks east and west and, in order to overcome as much as possible any slight unevenness in the soil, the experiments are arranged in short series in such a way that every plot becomes a control for its neighbour. This point will be clear on referring to the detailed plans below.

Reserve stocks.—After planting out any particular variety, it sometimes happens that some of the plants are killed by white-ants or damaged by wind. To meet accidents of this nature, a reserve of plants is kept in the nursery for replacing any dead or injured plants. By taking up the trees with a very large ball of earth it is easy to make good any losses and to preserve the uniformity of the rows.

End rows.—As is well known, the trees which constitute the border of a plantation grow under different conditions as regards soil and light to those in the interior, and should, therefore, not be included in an experiment. Accordingly at the north and south end of each block of trees, one or more rows has been left. These are described as "end trees" in the detailed plans.

Some characteristics of the soil.—Some indication of the nature of the soil in the experimental area may not be without interests. After the great ease of cultivation and the rapidity with which the soil dries after rain sufficiently to allow of most agricultural operations being performed, the most striking peculiarities are the formation of a skin on the surface and the destruction of the tilth by heavy rain. Similar results follow if the soil is flooded by irrigation water. During the monsoon a good deal of labour is involved in periodically breaking up the surface soil with the hoe after rain so as to allow of aëration of the roots. Freshly dug earth shrinks considerably after heavy rain, a fact which has to be taken into account when planting trees in pits. Young trees planted at the end of the cold season are best watered from below by means of a porous earth pot sunk near the plant. By keeping the vessel filled with water a continuous supply of moisture is available for the roots, and there is no destruction of the tilth and no formation of a surface pan.

Records.—The question of records and labels is an important one in dealing with a large number of trees. There are many disadvantages in attaching labels to young growing trees. In the case of peaches, for example, which grow with great rapidity, there is a danger of ringing at the point where the label is tied on. The system adopted at Pusa has been to do without labels altogether after the trees are planted out in the experimental plot. The plants are then indicated by numbers which begin in all cases at the south end. Two labels at the north and south ends of the rows indicate the variety. The details regarding the history, planting, and after treatment of the trees are entered in the registers.

Plan of Western Citrus Plot.

15' in rows, 20' between rows.

NORTH.

| | | | | | | | | |
|-------|----|---|---|---|---|---|--------------------------------|--|
| WEST. | 40 | x | x | x | x | End trees. | Stock experi- ments. | |
| | 39 | x | x | x | x | Wild citron stocks. | | |
| | 38 | x | x | x | x | | | |
| | 37 | x | x | x | x | Sweet lime " | | |
| | 36 | x | x | x | x | | | |
| | 35 | x | x | x | x | Wild citron " | | |
| | 34 | x | x | x | x | | | |
| | 33 | x | x | x | x | Sweet lime " | | |
| | 32 | x | x | x | x | | | |
| | 31 | x | x | x | x | Soil trenched 2' deep. | Planting experi- ments. | |
| | 30 | x | x | x | x | | | |
| | 29 | x | x | x | x | | | |
| | 28 | x | x | x | x | | | |
| | 27 | x | x | x | x | Surface soil dug. | | |
| | 26 | x | x | x | x | Surface soil undis- turbed. | | |
| | 25 | x | x | x | x | | | |
| | 24 | x | x | x | x | | | |
| | 23 | x | x | x | x | | | |
| | 22 | x | x | x | x | Trees planted in holes 6' diameter and 3' deep. | | |
| | 21 | x | x | x | x | | | |
| | 20 | x | x | x | x | | | |
| | 19 | x | x | x | x | No pruning. | Pruning experi- ments. | |
| | 18 | x | x | x | x | | | |
| | 17 | x | x | x | x | | | |
| | 16 | x | x | x | x | Trees pruned. | | |
| | 15 | x | x | x | x | | | |
| | 14 | x | x | x | x | | | |
| | 13 | x | x | x | x | Trees lightly pruned. | | |
| | 12 | x | x | x | x | | | |
| | 11 | x | x | x | x | | | |
| | 10 | x | x | x | x | Trees root-pruned and lightly pruned. | Root-pruning ex- periments. | |
| | 9 | x | x | x | x | | | |
| | 8 | x | x | x | x | | | |
| | 7 | x | x | x | x | Trees root-pruned. | | |
| | 6 | x | x | x | x | | | |
| | 5 | x | x | x | x | | | |
| | 4 | x | x | x | x | No root-pruning. | | |
| | 3 | x | x | x | x | | | |
| | 2 | x | x | x | x | | | |
| | 1 | x | x | x | x | End trees. | | |

Nagpur. Malda. Malda. Sylhet.
 Bhool.

SOUTH.

WESTERN CITRUS PLOT.

The experiments in this plot are concerned with the effect of (1) root-pruning, (2) different methods of planting, (3) branch pruning, and (4) the influence of various stocks on the growth and bearing power of the orange trees.

Varieties.—Four different varieties of oranges were selected for the experiments, namely, Nagpur, Malta, Sylhet, and Malta Blood. The plants in the root-pruning, pruning, and planting experiments are all budded on Sweet Chikna lime stocks. In the stock experiment they are budded either on limes or wild citrons. All the plants were raised at the Botanic Gardens, Saharaspur.

Preparation of the land and planting.—The initial cultivation of the land in this plot was only uniform as far as each of the experiments is concerned. The details are given below under the various experiments. The trees were planted in July, 1906. After planting, they were shaded by small conical shelters of millet straw supported by a bamboo tripod and open towards the north. In this way they are gradually hardened till new growth begins when the shelters are removed. By this means the loss on planting is generally less than one per cent. After planting, four pounds of rape cake was worked into the surface soil round each of the trees, and sunn hemp (*Crotalaria juncea*) was sown between the rows and ploughed in in September so as to increase the amount of organic matter in the soil.

Root-pruning experiment.—The soil in this section was trenched two feet deep just before the trees were planted, holes only just large enough to take the plants being made with the hoe (*kurpi*). The objects of the experiment are to determine the effect of root-pruning on the development of the orange tree and to ascertain whether the check to vegetative growth due to this operation should be accompanied by a light branch-pruning. Root-pruning is practised in India by the orange-growers in the Nagpur district at the time when the roots are exposed and the trees weathered just before the flowering period.

As a general rule the effect of root-pruning is to check the vegetative vigour of the tree and thus reduce the formation of wood. A small and manageable tree is thereby produced and at the same

time there is a tendency to increase fruitfulness. *The vegetative and fruit-producing activities of fruit trees are antagonistic.*

Pruning experiments.—As in the previous experiment, the soil was trenched to a depth of two feet before planting, and the young trees were placed in small holes sufficiently large to receive them. The object of the experiment is to ascertain the effect of varying amounts of pruning on the growth of the orange tree.

Planting experiments.—Very interesting results have been obtained in England on the influence of the preparation of the soil on the development of fruit trees. It was found that the root development and also the growth of the above-ground portion of the tree are profoundly affected by the various methods of planting. The better the preparation of the soil, the more symmetrical and robust are the trees. In order to ascertain whether similar results are to be expected in such soils as those of Pusa four different methods of planting have been tried. If it is found that the development of trees is similar in all cases and the method of planting has no effect, the trees in this part of the plot will be available for any further experiments which may suggest themselves later.

Stock experiments.—The experiment on the effect of different stocks on the development of the plant and the character of the fruit has been duplicated. The trees in the first two plots (32—35) were planted in soil which was trenched to a depth of three feet six inches—a proceeding which was rendered necessary by the occurrence of a fox earth in this part of the plot. The trees in the duplicate plot (Nos. 36—39) were planted in holes six feet in diameter and three feet deep.

The great effect of the stock in the case of fruit trees is a subject the importance of which has been widely recognized in the growth of temperate fruits, and it has been found possible to grow choice varieties in a wide range of soils, provided the most suitable stock is selected. In general the scion is influenced by the stock in the size and flavour of its fruit, in the earliness or lateness of its fruit-bearing power and in its habit of growth. It is probable that these results are connected with the transfer of food materials at the point of union of stock and scion.

* Journal of the South-Eastern Agricultural College, Wye, Kent, 1903.

Plan of Eastern Citrus Plot.

15 in rows, 20 between rows.

NORTH.

| | | | | | | | | | | | | |
|------|----|---|---|---|---|---|---|---|---|---|---------------------------------|------------------------|
| WEST | 40 | x | x | x | x | x | x | x | x | x | End trees. | Irrigation experiment. |
| | 39 | x | x | x | x | x | x | x | x | x | Not irrigated or weathered. | |
| | 38 | x | x | x | x | x | x | x | x | x | | |
| | 37 | x | x | x | x | x | x | x | x | x | | |
| | 36 | x | x | x | x | x | x | x | x | x | Not irrigated. | |
| | 35 | x | x | x | x | x | x | x | x | x | | |
| | 34 | x | x | x | x | x | x | x | x | x | | |
| | 33 | x | x | x | x | x | x | x | x | x | Irrigated. | |
| | 32 | x | x | x | x | x | x | x | x | x | | |
| | 31 | x | x | x | x | x | x | x | x | x | | |
| | 30 | x | x | x | x | x | x | x | x | x | Normal cultivation. | |
| | 29 | x | x | x | x | x | x | x | x | x | | |
| | 28 | x | x | x | x | x | x | x | x | x | | |
| | 27 | x | x | x | x | x | x | x | x | x | Not cultivated (weeds removed). | |
| | 26 | x | x | x | x | x | x | x | x | x | | |
| | 25 | x | x | x | x | x | x | x | x | x | Surface grassed down. | |
| | 24 | x | x | x | x | x | x | x | x | x | | |
| | 23 | x | x | x | x | x | x | x | x | x | | |
| | 22 | x | x | x | x | x | x | x | x | x | | |
| | 21 | x | x | x | x | x | x | x | x | x | Green manure. | |
| | 20 | x | x | x | x | x | x | x | x | x | | |
| | 19 | x | x | x | x | x | x | x | x | x | | |
| | 18 | x | x | x | x | x | x | x | x | x | Green manure. | Manure experiment. |
| | 17 | x | x | x | x | x | x | x | x | x | No manure. | |
| | 16 | x | x | x | x | x | x | x | x | x | | |
| | 15 | x | x | x | x | x | x | x | x | x | Farmyard manure. | |
| | 14 | x | x | x | x | x | x | x | x | x | | |
| | 13 | x | x | x | x | x | x | x | x | x | | |
| | 12 | x | x | x | x | x | x | x | x | x | | |
| | 11 | x | x | x | x | x | x | x | x | x | Weathered in January. | |
| | 10 | x | x | x | x | x | x | x | x | x | | |
| | 9 | x | x | x | x | x | x | x | x | x | | |
| | 8 | x | x | x | x | x | x | x | x | x | Not weathered. | |
| | 7 | x | x | x | x | x | x | x | x | x | | |
| | 6 | x | x | x | x | x | x | x | x | x | | |
| | 5 | x | x | x | x | x | x | x | x | x | Weathered in May. | |
| | 4 | x | x | x | x | x | x | x | x | x | | |
| | 3 | x | x | x | x | x | x | x | x | x | | |
| | 2 | x | x | x | x | x | x | x | x | x | End trees. | |
| | 1 | x | x | x | x | x | x | x | x | x | | |

| | | | | | | | | | | | |
|---------|---------|-------|---------|--------|-------|--------|--------|---------|---------|-----------|--------------|
| Kaghal. | Sylhet. | Sweet | Chikna. | Makha. | Matta | Blood. | Makha. | Sylhet. | Nagpur. | Mardarin. | Red Besighl. |
|---------|---------|-------|---------|--------|-------|--------|--------|---------|---------|-----------|--------------|

Limes.

Lemons.

Oranges.

Pamela.

SOUTH.

EASTERN CITRUS PLOT.

The experiments in this plot are designed to ascertain the effect on the growth of citrus plants, including limes, lemons, oranges, and pumelos, of (1) weathering (resting the trees), (2) manure (including green manure), (3) the condition of the surface soil, and (4) irrigation.

Varieties.—Three varieties of seedling limes—Kaghzi, Sylhet, and Sweet Chikna—were selected for these experiments. The single row of lemons are seedlings of the Malta variety. There are five varieties of budded oranges—Malta Blood, Malta, Sylhet, Nagpur, and Mandarin. The Nagpur plants are on Jamburi stocks, the other four on Sweet Chikna limes. The red fleshed pumelos are also budded on sweet lime stocks. The Nagpur oranges were obtained from a garden near Nagpur, and the rest of the plants in the plot from the Botanic Gardens, Saharanpur.

Preparation of the land and planting.—All the trees in this plot were planted uniformly in holes five feet in diameter and three feet deep. Before filling in, the soil was mixed with the following:—two baskets of *sarkhi* (finely broken bricks), one and a half baskets of leaf-mould, and half a basket of rape cake. The *sarkhi* was added to render the soil more porous and to prevent the excessive running together of the surface after rain. In filling up the pits it was found better to consolidate moderately the soil in the lower half and afterwards to prepare a mound about six inches above the general surface so as to allow of future settlement. Unless this point is borne in mind, the earth in the pits will settle into a saucer-like depression during the rains, and the young trees will be destroyed by water-logging. All the trees in this plot, except the Nagpur oranges, were planted at the end of September and the beginning of October, 1905. The Nagpur trees were planted at the end of March of the same year. The trees were watered by means of porous earthen pots sunk in the soil on one side of the plant. By keeping the vessel filled with water, a continuous supply of moisture was available for the plants without interfering with the condition of the surface soil round the young trees. In adopting this method care must be taken to see that the pots are buried in such a way that no air spaces are left between the earthenware and the soil, otherwise there is a danger of the young trees drying up

during the hot weather from April to June. The plants were protected during the cold weather of 1905-06 from frost by means of conical millet straw covers open on the south side towards the sun. On account of the lateness of planting, the trees had made but little growth and were not well established at the period when frosts were to be expected. During the hot weather of 1906, considerable trouble was caused by the attacks of grasshoppers. In order to protect the trees, it was found necessary to sow sunflower between the rows as a food plant for these pests. The caterpillars, which feed on the young leaves of citrus plants, were hand-picked by boys and destroyed by placing them in a vessel of water covered by a film of kerosine oil.

Weathering experiment.—This experiment is designed to show the effect of weathering on the bearing power of citrus plants and to compare the results when this operation is performed previous to the two principal flowering periods—February and June. It is the custom of the orange-growers in the neighbourhood of Nagpur to rest the trees before flowering by cutting off the supply of water and exposing the roots to the air. Manure is generally applied when the soil is returned to the trees. It will be of interest to ascertain whether the trees can be made to flower and set fruit at Pusa before the rains begin at the end of June.

Manurial experiment.—The object of this experiment is to determine the effect of cattle and green manure. A no-manure plot has been added for purposes of control and also to ascertain to what extent the remarkable results obtained at Woburn on the absence of effect of manures on the growth and bearing power of young fruit trees, are applicable to Indian conditions. In view of the fact that artificial manures are not likely to be within the reach of the Indian cultivator, no experiments have been started with these substances. A comparison, however, between the results of cattle manure applied in the cold weather and the effect of green manure grown between the rows during the rains and dug in early in September has been arranged for. Both these methods of manuring are within the means of fruit-growers in India and do not entail any considerable expenditure of money. The crop selected for

* Fourth report of the Woburn Experimental Fruit Farm by the Duke of Bedford and Spencer U. Pickering, F.R.S., 1904.

purposes of green manuring is sunn hemp (*Crotalaria juncea*), a quick growing leguminous plant which thrives in Behar.

Cultivation experiment.—The condition of the surface and the amount of cultivation required are problems which have exercised fruit-growers in all parts of the world. The experience in North America favours a well cultivated surface. A similar practice is largely adopted in England, especially in the newer orchards, although many of the best of the older fruit grounds are under grass. The remarkable results obtained at Woburn* on the ill-effects of grass on the growth and bearing power of fruit trees naturally suggest similar experiments in India. In addition to the grassed plot, there are two others—one in which the soil will be cultivated and the other in which there will be no cultivation—beyond that involved in periodical weeding. The soil at Pusa, like that in many parts of the plains of India, is prone to run together into a cement-like surface after rain, and in all probability this is very detrimental to plant growth as it very likely interferes with the supply of air to the roots. It will be interesting to see whether the trees require any more cultivation than that by which the surface is periodically broken up during the operation of weeding.

Irrigation experiments.—The results obtained by Leake† on the rise of moisture in the soils of Behar during the hot weather, and the fact that many of the trees come into leaf at the beginning of the hot season and make considerable growth before the monsoon, suggest the desirability of comparing the behaviour of trees with and without irrigation during this period. Accordingly two plots have been set apart for this purpose, as well as one in which the trees are neither watered nor irrigated. To prevent the percolation of water from adjacent areas, the unirrigated trees are placed at the highest point of the plot on the northern side.

* Third report of the Woburn Experimental Fruit Farm by the Duke of Bedford and Spencer U. Pickering, F.R.S., 1903.

† H. M. Leake, *Journal of Agricultural Science*, Vol. 1, 1906.

Plan of Plum Plot.

Trees 15' in rows, 20' between rows.
NORTH.

| | | | | | |
|-------|----|---|---|----------------------------------|------------------------------|
| WEST. | 34 | X | X | End trees. | |
| | 33 | X | X | | |
| | 32 | X | X | Not irrigated or weathered. | |
| | 31 | X | X | | |
| | 30 | X | X | | |
| | 29 | X | X | Not irrigated. | Irrigation experi- ment. |
| | 28 | X | X | | |
| | 27 | X | X | Irrigated. | |
| | 26 | X | X | | |
| | 25 | X | X | Normal cultivation. | |
| | 24 | X | X | | |
| | 23 | X | X | | |
| | 22 | X | X | Not cultivated (wood s removed). | Cultivation experi- ment. |
| | 21 | X | X | | |
| | 20 | X | X | Surface grassed down. | |
| | 19 | X | X | | |
| | 18 | X | X | Green manure. | |
| | 17 | X | X | | |
| | 16 | X | X | No manure. | Manurial experi- ment. |
| | 15 | X | X | | |
| | 14 | X | X | Fermyard manure. | |
| | 13 | X | X | | |
| | 12 | X | X | Root-pruned. | |
| | 11 | X | X | | |
| | 10 | X | X | No pruning | Pruning experi- ment. |
| | 9 | X | X | Pruned. | |
| | 8 | X | X | | |
| | 7 | X | X | | |
| | 6 | X | X | Weathered. | Weathering ex- periment. |
| | 5 | X | X | Not weathered. | |
| | 4 | X | X | | |
| | 3 | X | X | | |
| | 2 | X | X | End trees. | |
| | 1 | X | X | | |

Large Yellow
Albukhara. Alncha.

SOUTH.

PLUMS.

The manurial, cultivation, and irrigation experiments with plums are arranged on similar lines to those in the eastern citrus plot. In addition there are pruning and weathering experiments.

Varieties.—Two varieties of plums which fruit on the plains were selected, namely, large Alubakhara and yellow Alucha. The trees were raised from cuttings and were obtained from the Botanical Gardens, Saharanpur.

Preparation of the land and planting. The trees in this plot were planted in holes and manured in a similar manner to that adopted in the eastern citrus plot. The method of watering at the beginning by means of sunk earthen pots was also used in this plot. Planting was carried out at the end of September and the beginning of October, 1905.

Weathering experiment.—In order to check the vegetative vigour of those deciduous stone fruited trees which thrive in the plains, and at the same time to induce fruit bearing, the practice of weathering the trees by exposing the surface roots to the air during December is said to be of value in India. A small plot has, therefore, been arranged to determine the value of this practice.

Pruning experiment. The fact that the plum bears its fruit on spurs on the older wood and that extensive pruning tends to develop the formation of these fruit-bearing spurs suggests the desirability of comparing branch-pruned and root-pruned trees with those which are allowed to grow unchecked. It is possible that the check to vegetative growth due to root pruning may be more effective than branch pruning.

Manurial, cultivation and irrigation experiments.—These are similar to those in the eastern citrus plot. As the alignment of both these plots is the same, a considerable saving of labour will be effected in carrying out the experiments as the trees from 13 to 40 in both plots will receive the same treatment.

Plan of Custard Apple Plot.

20 in rows, 25 between rows.

NORTH.

| | | | | | |
|-------|----|---|---|--------------------------------|-------------------------|
| WEST. | 30 | x | x | End trees. | |
| | 29 | x | x | Not irrigated or weathered. | |
| | 28 | x | x | | |
| | 27 | x | x | Not irrigated. | Irrigation experiment. |
| | 26 | x | x | | |
| | 25 | x | x | Irrigated. | |
| | 24 | x | x | | |
| | 23 | x | x | Normal cultivation. | |
| | 22 | x | x | | |
| | 21 | x | x | | |
| | 20 | x | x | Uncultivated, (weeds removed). | Cultivation experiment. |
| | 19 | x | x | | |
| | 18 | x | x | Grassed down. | |
| | 17 | x | x | | |
| | 16 | x | x | | |
| | 15 | x | x | | |
| | 14 | x | x | Green manure. | |
| | 13 | x | x | | |
| | 12 | x | x | No manure. | Manure experiment. |
| | 11 | x | x | | |
| | 10 | x | x | Farmyard manure. | |
| | 9 | x | x | | |
| | 8 | x | x | Not weathered. | Weathering experiment. |
| | 7 | x | x | | |
| | 6 | x | x | | |
| | 5 | x | x | Weathered. | |
| | 4 | x | x | | |
| | 3 | x | x | | |
| | 2 | x | x | End trees. | |
| | 1 | x | x | | |

Fyzabad. Saharanpur.
SOUTH.

CUSTARD APPLES.

Like the guava, the custard apple flowers in May, and the fruit is in season during the greater part of the rains and cold weather. These facts have, therefore, to be borne in mind in conducting the weathering, manurial, cultivation, and irrigation experiments with this fruit tree. A judicious system of pruning is said to improve the bearing power of the custard apple.

Varieties.—All the plants in this plot are seedlings from the United Provinces: one row was obtained from Fyzabad where the best custard apples are said to grow, and the other from the Botanical Gardens, Saharanpur.

Preparation of the soil and planting.—The trees were planted in holes without the addition of any manure at the beginning of the monsoon of 1906. Until new growth appeared and the plants were hardened off, they were shaded by means of conical shelters of millet straw open on the north side. In spite of a long break in the rains no plants were lost.

Weathering experiment.—The trees will be weathered after the crop is over towards the end of the cold weather before the new leaves appear. At Pusa the custard apple is practically deciduous.

Manurial experiment.—The green manure will be put under at the beginning of September and the cattle manure at the time the trees are weathered in the cold season.

Cultivation and irrigation experiments.—These experiments are on similar lines to those in the citrus and plum plots and call for no special comment.

Plan of Loquat Plot.

20' in rows, 25' between rows.

NORTH.

| | | | | | |
|-------|----|---|------------------|-------------------------------|--------------------------|
| WEST. | 30 | x | x | End trees | |
| | 29 | x | x | Not irrigated or weathered. | Irrigation experiments. |
| | 28 | x | x | | |
| | 27 | x | x | Not irrigated. | |
| | 26 | x | x | | |
| | 25 | x | x | Irrigated. | |
| | 24 | x | x | | |
| | 23 | x | x | Normal cultivation. | Cultivation experiments. |
| | 22 | x | x | | |
| | 21 | x | x | | |
| | 20 | x | x | Uncultivated (weeds removed). | |
| | 19 | x | x | | |
| | 18 | x | x | | |
| | 17 | x | x | Grassed down. | Manurial experiment. |
| | 16 | x | x | | |
| | 15 | x | x | | |
| | 14 | x | x | Green manure. | |
| | 13 | x | x | | |
| | 12 | x | x | No manure. | |
| | 11 | x | x | | |
| 10 | x | x | Farmyard manure. | | |
| 9 | x | x | | | |
| 8 | x | x | Not weathered. | Weathering experiment. | |
| 7 | x | x | | | |
| 6 | x | x | | | |
| 5 | x | x | Weathered. | | |
| 4 | x | x | | | |
| 3 | x | x | | | |
| 2 | x | x | End trees. | | |
| 1 | x | x | | | |

Pale yellow. Golden yellow.

SOUTH.

LOQUATS.

The experiments with this tree are on similar lines to those of the western peach plot. As the flowers of the loquat are borne only at the extremities of the short shoots, pruning has to be done with great care so that no new shoots are cut off. Only the ends of the old shoots which have carried fruit should be cut back.

Varieties.—Two varieties of loquats—pale yellow (Agra) and golden yellow—grafted on seedling loquat stocks were obtained for this experiment from the Botanical Gardens, Saharanpur.

Preparation of the land and method of planting.—Both varieties were planted in holes, and manure, composed of two baskets of *sarkhi*, one and a half of leaf-mould and half a basket of oil cake, was added to the soil before filling in. The trees were planted in September, 1905, towards the end of the monsoon and watering was carried out by means of sunken earthen pots. The water thus given to the plants was found insufficient during the hot weather of 1906, so the trees were all irrigated.

Weathering experiment.—As the flowers appear towards the end of November, weathering should be done before this takes place. Firminger says: "About the middle of October the roots should be laid bare and allowed to remain so for a week, after which they should be closed in. A good watering to begin with will be found very beneficial."

Manurial experiment.—The green manure will be dug in early in September and the cattle manure applied after the exposure of the roots in October.

Cultivation experiment.—This is on the usual lines and call for no comment.

Irrigation experiment.—As the fruit ripens from the middle of March to the middle of April, and as the loquat requires a good deal of water during the hot months, irrigation should have a marked effect on this tree.

PEARS.

An attempt was made in December, 1905, to grow two varieties of pears at Pusa. The sorts selected were China (cuttings) and La

Coulé (grafts on seedling pear stocks) from the Botanical Gardens, Saharanpur. All the plants came into leaf in February but after a time they began to die off, and at the present time not more than fifty per cent. have survived. It was found that the trees were in all cases attacked by white-ants, and it would appear that this plant is specially relished by this pest. A further attempt will be made to replant this plot and the trees will be copiously irrigated so as to force them on as rapidly as possible during the hot weather. If it is possible to establish an even stand of trees, the plot will be used for experiments. If not, some other fruit trees will be planted.

Plan of Western Peach Plot.

20 in rows, 25 between rows.

NORTH.

| | | | | | | | | | | | |
|-------|----|---|---|---|---|---|---|---|-------------------------------|-------------------------|------------------------|
| WEST. | 30 | x | x | x | x | x | x | x | End trees. | | |
| | 29 | x | x | x | x | x | x | x | Not irrigated or weathered. | | |
| | 28 | x | x | x | x | x | x | x | | | |
| | 27 | x | x | x | x | x | x | x | Not irrigated. | | Irrigation experiment. |
| | 26 | x | x | x | x | x | x | x | | | |
| | 25 | x | x | x | x | x | x | x | Irrigated. | | |
| | 24 | x | x | x | x | x | x | x | | | |
| | 23 | x | x | x | x | x | x | x | Normal cultivation. | | |
| | 22 | x | x | x | x | x | x | x | | | |
| | 21 | x | x | x | x | x | x | x | | | |
| | 20 | x | x | x | x | x | x | x | Uncultivated (weeds removed). | Cultivation experiment. | |
| | 19 | x | x | x | x | x | x | x | | | |
| | 18 | x | x | x | x | x | x | x | | | |
| | 17 | x | x | x | x | x | x | x | Grassed down. | | |
| | 16 | x | x | x | x | x | x | x | | | |
| | 15 | x | x | x | x | x | x | x | | | |
| | 14 | x | x | x | x | x | x | x | Green manure. | | |
| | 13 | x | x | x | x | x | x | x | | | |
| | 12 | x | x | x | x | x | x | x | No manure. | Manurial experiment. | |
| | 11 | x | x | x | x | x | x | x | | | |
| | 10 | x | x | x | x | x | x | x | Farmyard manure. | | |
| | 9 | x | x | x | x | x | x | x | | | |
| | 8 | x | x | x | x | x | x | x | Not weathered. | | |
| | 7 | x | x | x | x | x | x | x | | | |
| | 6 | x | x | x | x | x | x | x | | | |
| | 5 | x | x | x | x | x | x | x | Weathered. | Weathering experiment. | |
| | 4 | x | x | x | x | x | x | x | | | |
| | 3 | x | x | x | x | x | x | x | | | |
| | 2 | x | x | x | x | x | x | x | End trees. | | |
| | 1 | x | x | x | x | x | x | x | | | |

Honey.
Hakim.
Country No. 4.
Country No. 3.
Country No. 2.
Country No. 1.
Hardsol.

SOUTH.

WESTERN PEACH PLOT.

The experiments in this plot are designed to test the effect of (1) weathering, (2) manure (including green manure), (3) different methods of treating the surface soil, and (4) irrigation, on the growth and bearing power of peach trees.

Varieties.—Seven varieties of peaches were selected for this plot from the Botanical Gardens, Saharanpur, namely, Country No. 1, Country No. 2, Country No. 3, Country No. 4, Honey, Hardoi, and Hakim. All the trees are budded on seedling peach stocks.

Preparation of the land and planting.—All the varieties were planted in holes five feet in diameter and three feet deep and the soil was mixed with *sarkhi* two and a half (baskets) leaf-mould (one and a half baskets) and rape cake (half basket) before filling in. Until the monsoon of 1906, the trees were watered when necessary by means of buried earthen pots. Sunn hemp was sown between the rows during the monsoon and buried green in September, 1906. The trees were planted in August, 1905, and have made considerable growth and are very even in size. The experiments will be commenced in December of this year, and it is probable that the trees will bear a crop next year. On account of the vigorous growth of the peach at Pusa, great care has been necessary in removing all shoots which arise from the stock below the point of insertion of the bud. This plot was purposely planted in the highest portion of the fruit experiment plot as the peach does best on sandy soils. Water-logging during the rains is fatal to the growth of this tree, which must have a free draining sub-soil.

Weathering experiment.—As a rule in the plains the peach makes such vigorous growth of wood that some plan is necessary to assist in ripening it. Firminger recommends that shortly after the close of the rains the earth should be removed from round the stem to a distance of a foot to a foot and a half and the roots laid bare and be allowed to continue so during five or six weeks. Accordingly the behaviour of weathered and unweathered trees will be compared for some years.

Manurial experiment.—The great vegetative vigour of the peach trees at Pusa suggests that there is a great danger of over-manuring this fruit tree. It is quite possible that too much manure

would result in the formation of unripe wood of an unfruitful character. None of the trees in the plot outside this experiment will be manured unless experience shows that such treatment is necessary. In the manurial experiments the green manure will be dug in at the beginning of September and the cattle manure applied at the end of the operation of weathering.

Cultivation experiment.—This experiment is on similar lines to that in the plots previously dealt with. In view of the sensitiveness of the peach tree to soil conditions, interesting results should be obtained in this experiment. It seems reasonable to expect that the trees in the cultivated plot, where the soil will be kept in an open condition, will do better than those under grass and those in the plot where the only cultivation is that involved in the operation of weeding.

Irrigation experiment.—Special care is said to be necessary in India in the irrigation of the peach tree, too much water at the beginning and end of the crop being harmful. In addition to the influence of irrigation, it will be interesting to see how far the peach will be able to supply itself with water during the hottest period of the year.

Plan of Guava Plot.

20' in rows, 25' between rows.

NORTH.

| | | | | | | | |
|-------|----|---|---|---|---|-------------------------------|-------------------------|
| WEST. | 20 | x | x | x | x | End trees. | |
| | 23 | x | x | x | x | Not irrigated or weathered. | Irrigation experiment. |
| | 28 | x | x | x | x | | |
| | 27 | x | x | x | x | Not irrigated. | |
| | 26 | x | x | x | x | | |
| | 25 | x | x | x | x | | Cultivation experiment. |
| | 24 | x | x | x | x | Irrigated. | |
| | 23 | x | x | x | x | | |
| | 22 | x | x | x | x | Normal cultivation. | |
| | 21 | x | x | x | x | | Cultivation experiment. |
| | 20 | x | x | x | x | Uncultivated (woods removed). | |
| | 19 | x | x | x | x | | |
| | 18 | x | x | x | x | | |
| | 17 | x | x | x | x | | Manure experiment. |
| | 16 | x | x | x | x | Grassed down. | |
| | 15 | x | x | x | x | | |
| | 14 | x | x | x | x | | |
| | 13 | x | x | x | x | Green manure. | Weathering experiment. |
| | 12 | x | x | x | x | | |
| | 11 | x | x | x | x | No manure. | |
| | 10 | x | x | x | x | Manure. | |
| | 9 | x | x | x | x | Manure. | Fruiting experiment. |
| | 8 | x | x | x | x | | |
| | 7 | x | x | x | x | Late fruiting only. | |
| | 6 | x | x | x | x | | |
| | 5 | x | x | x | x | Not weathered. | Weathering experiment. |
| | 4 | x | x | x | x | | |
| | 3 | x | x | x | x | Weathered. | |
| | 2 | x | x | x | x | | |
| | 1 | x | x | x | x | End trees. | |

Allahabad Seedlings. Sufaid. Smooth green. Cattley's.

SOUTH.

GUAVAS.

The guava, unlike the peach, is evergreen and the fruit is borne during the rains and cold weather. Consequently the irrigation, cultivation, manurial, and weathering experiments with this plant have to be modified accordingly. There is a further experiment on the effect of the prevention of fruiting during the rains.

Varieties.—Four varieties were selected for these experiments—Allahabad, Sufaida, Smooth Green and Cattley's. The plants of the first variety are seedlings from the Botanic Gardens, Lahore, those of the second are grafts on seedling guava stocks from the Allahabad Botanic Gardens. Smooth Green and Cattley's are seedlings from Saharanpur. Considerable difficulty was experienced in obtaining these plants in sufficient numbers for these experiments.

Preparation of the land and planting.—All the varieties were planted in holes and were unmanured at the time of planting. Cattley's guava and Smooth Green were planted in October, 1905, the Allahabad seedlings in June, 1906, and the Sufaida grafts in August, 1906. Sunn hemp was sown between the rows and ploughed in in September, 1906. The Smooth Green variety has made considerable growth, and a few fruits were borne during the monsoon of 1906. The experiments in this plot will be started during the hot weather of 1907, when it is expected all the trees will be well established.

Weathering.—On account of the fruiting period of the guava, the trees will have to be weathered in May about the same time as the growth of the orange is checked before the second flowering.

Fruiting experiment.—The crops born after the rains are said to be much superior in quality to those which ripen during the monsoon. It will be interesting, therefore, to ascertain the effect of preventing early fruiting on the character of the later crops.

Manurial experiment.—The cattle manure will be applied during the hot weather just before flowering begins, while the green manure will be grown during the rains and put under in September.

Irrigation experiment.—The effect of irrigation will probably be less in this crop than in those which ripen their fruits during the hot weather. Some result may possibly be obtained by irrigation before and after the monsoon.

Plan of Litchi Plot.

20' in rows, 25' between rows.
NORTH.

| | | | | | | | |
|-------|----|---|---|---|---|-------------------------------|-------------------------|
| WEST. | 30 | x | x | x | x | End trees. | Irrigation experiment. |
| | 29 | x | x | x | x | Not irrigated or weathered. | |
| | 28 | x | x | x | x | | |
| | 27 | x | x | x | x | Not irrigated. | |
| | 26 | x | x | x | x | | Cultivation experiment. |
| | 25 | x | x | x | x | Irrigated. | |
| | 24 | x | x | x | x | | |
| | 23 | x | x | x | x | Normal cultivation. | |
| | 22 | x | x | x | x | | Weathering experiment. |
| | 21 | x | x | x | x | | |
| | 20 | x | x | x | x | Uncultivated (weeds removed). | |
| | 19 | x | x | x | x | | |
| | 18 | x | x | x | x | | Manure experiment. |
| | 17 | x | x | x | x | Grassed down. | |
| | 16 | x | x | x | x | | |
| | 15 | x | x | x | x | | |
| | 14 | x | x | x | x | Green manure. | |
| | 13 | x | x | x | x | | |
| | 11 | x | x | x | x | No manure. | |
| | 12 | x | x | x | x | | |
| | 10 | x | x | x | x | Farmyard manure. | |
| | 9 | x | x | x | x | | |
| | 8 | x | x | x | x | Not weathered. | |
| | 7 | x | x | x | x | | |
| | 6 | x | x | x | x | | |
| | 5 | x | x | x | x | Weathered. | |
| | 4 | x | x | x | x | | |
| | 3 | x | x | x | x | | |
| | 2 | x | x | x | x | End trees. | |
| | 1 | x | x | x | x | | |

Muzaffarpore. Saharanpur. Muzaffarpore. Muzaffarpore.

SOUTH.

LITCHIS.

The experiments include the effect of (1) weathering, (2) different manurial treatment, (3) various methods of treating the surface soil, and (4) the influence of irrigation, on the development of the litchi.

Varieties.—Two varieties were selected for the experiments. The layers of Muzaffarpore litchi were obtained from a cultivator's garden in that town, the Saharanpur variety from the Botanical Gardens there.

Preparation of the land and planting.—All the trees were planted in holes and no manure was added at planting time. Sunn hemp was sown between the rows and turned in green in September, 1906. Two of the rows of Muzaffarpore litchis were planted in October, 1905, the third in September, 1906. The Saharanpur plants were put in in August, 1906.

Weathering experiment.—As the litchi flowers in February, the effect of weathering will have to be tried in January before the flower buds and new leaves appear.

Manurial and cultivation experiments.—These are on similar lines to those in other plots and call for no special remarks.

Irrigation experiment.—The fact that the litchi bears its fruit, and makes considerable growth of wood during the hot weather, makes it likely that the effect of withholding irrigation water will be marked.

Plan of Mango Plot.

25' in rows, 30' between rows.

NORTH.

| | | | | | | | | | | |
|-------|----|---|---|---|---|---|---|------------------|---------------------------------|-------------------------|
| WEST. | 24 | x | x | x | x | x | x | x | Not irrigated or weathered. | Irrigation experiment. |
| | 23 | x | x | x | x | x | x | x | | |
| | 22 | x | x | x | x | x | x | x | | |
| | 21 | x | x | x | x | x | x | x | | |
| | 20 | x | x | x | x | x | x | x | Not irrigated. | |
| | 19 | x | x | x | x | x | x | x | | |
| | 18 | x | x | x | x | x | x | x | Irrigated. | |
| | 17 | x | x | x | x | x | x | x | | |
| | 16 | x | x | x | x | x | x | x | No shade. | Shade experiment. |
| | 15 | x | x | x | x | x | x | x | | |
| | 14 | x | x | x | x | x | x | x | | |
| | 13 | x | x | x | x | x | x | x | | |
| | 12 | x | x | x | x | x | x | x | Shaded by bananae. | |
| | 11 | x | x | x | x | x | x | x | | |
| | 10 | x | x | x | x | x | x | x | Deep cultivation | |
| | 9 | x | x | x | x | x | x | x | | |
| | 8 | x | x | x | x | x | x | x | No cultivation (weeds removed). | Cultivation experiment. |
| | 7 | x | x | x | x | x | x | x | | |
| | 6 | x | x | x | x | x | x | x | | |
| | 5 | x | x | x | x | x | x | x | | |
| | 4 | x | x | x | x | x | x | x | Grassed over. | |
| | 3 | x | x | x | x | x | x | x | | |
| | 2 | x | x | x | x | x | x | x | Green manure. | |
| | 1 | x | x | x | x | x | x | x | | |
| | | | | | | | | No manure. | | Manurial experiment. |
| | | | | | | | | | | |
| | | | | | | | | Farmyard manure. | | |
| | | | | | | | | | | |
| | | | | | | | | Not weathered. | Weathering experiment. | |
| | | | | | | | | | | |
| | | | | | | | | Weathered. | | |
| | | | | | | | | | | |
| | | | | | | | | End trees. | | |
| | | | | | | | | | | |

Alphonso.
 Pinte.
 Strawberry.
 Gopal Bhagr.
 Malda.
 Faizan.
 Stalkast.
 Bhadran.

SOUTH.

MANGOS.

In addition to the usual weathering, manurial, cultivation, and irrigation experiments, a small plot has been set aside to determine the effect of shade on the growth of young mango trees.

Varieties.—English varieties of grafted mangos have been selected for these experiments. The Alphonso plants were obtained from Bombay, Pirie from the Empress Gardens, Poona, Gopal Bhog and Malda from Calcutta and Faizan, Stalkart, Strawberry and Bhadaurea from the Botanical Gardens, Saharanpur.

Preparation of the land and planting.—All the trees were planted in holes and were unmanured at planting time. Sunn hemp was sown between the rows and turned under in September, 1906. The Saharanpur varieties and Malda were planted in August, 1906, the remainder in October, 1905. These latter rows were protected from the cold of 1905-06 by means of millet straw shelters open towards the south. The slope of the land was found to be insufficient to carry off the continuous rainfall in August of the present year, and the plants showed signs of water-logging.*

Weathering experiment.—Referring to the question of weathering, Firminger states that "the mango, like all other fruit trees, is much benefited by having the earth round it removed and the roots left exposed for two or three weeks." This operation is best done in November after the last growth of the year has taken place.

Manurial experiment.—The subject of the manuring of the mango tree does not seem to be understood as the most contradictory statements regarding the practice are to be found.

Cultivation experiment.—It seems agreed that in order to obtain good results, frequent cultivation is necessary with this tree.

Shade experiment.—While some of the fruit trees of the plains of India certainly grow rapidly without shade, it is said that shade is an advantage with young mango trees. An experiment on this point has, therefore, been arranged—one plot will be grown without shade, the other shade with banana trees.

* Since writing the above it has been found that the damage done by water-logging has been greater than was at first expected. Many of the trees died during the autumn of 1906. On digging them up it was found that most of the roots had decayed. During 1907 it is proposed to test the system of growing the young trees on mounds combined with good surface drainage. If this is successful the plot will be replanted.

Irrigation experiment.— It is stated that irrigation is not required for the mango in Bengal. In case negative results are obtained, the trees in this plot will be available for other purposes.

Plan of Fig Plot.

15' in rows, 20' between rows.

NORTH.

| | | | | | | |
|-------|----|---|---|---|---------------------------------|-------------------------|
| WEST. | 39 | x | x | x | End trees. | |
| | 38 | x | x | x | Not irrigated or weathered. | |
| | 37 | x | x | x | | |
| | 36 | x | x | x | | |
| | 35 | x | x | x | Not irrigated. | Irrigation experiment. |
| | 34 | x | x | x | | |
| | 33 | x | x | x | | |
| | 32 | x | x | x | Irrigated. | |
| | 31 | x | x | x | | |
| | 30 | x | x | x | | |
| | 29 | x | x | x | Normal cultivation. | |
| | 28 | x | x | x | | |
| | 27 | x | x | x | | |
| | 26 | x | x | x | No cultivation (weeds removed). | Cultivation experiment. |
| | 25 | x | x | x | | |
| | 24 | x | x | x | | |
| | 23 | x | x | x | Grassed down. | |
| | 22 | x | x | x | | |
| | 21 | x | x | x | | |
| | 20 | x | x | x | Green manure. | |
| | 19 | x | x | x | | |
| | 18 | x | x | x | | |
| | 17 | x | x | x | No manure. | Manorial experiment. |
| | 16 | x | x | x | | |
| | 15 | x | x | x | | |
| | 14 | x | x | x | Farmyard manure. | |
| | 13 | x | x | x | | |
| | 12 | x | x | x | | |
| | 11 | x | x | x | Weathered heavy-root pruning. | |
| | 10 | x | x | x | | |
| | 9 | x | x | x | | |
| | 8 | x | x | x | Not weathered. | Weathering experiment. |
| | 7 | x | x | x | | |
| | 6 | x | x | x | | |
| | 5 | x | x | x | Weathered light-root pruning. | |
| | 4 | x | x | x | | |
| | 3 | x | x | x | | |
| | 2 | x | x | x | End trees. | |
| | 1 | x | x | x | | |

Black Ischia. Barrie's. Poona purple.

SOUTH.

FIG.

The experiments with this plant include the effect of (1) weathering, (2) manure, (3) different methods of treating the surface soil, and (4) irrigation.

Varieties.—Three varieties of fig were selected for these experiments. The cuttings of Black Ischia and Barrie's were obtained from the Botanical Gardens, Saharanpur, and those of the purple Poona fig from the Empress Gardens, Poona.

Preparation of the soil and planting.—All the trees were planted in holes, and were unmanured at planting time in October, 1905. They have made good growth and are already well established.

Weathering experiment.—This operation is said to be of great importance in the case of the fig and should be done at the end of August, when the roots should be exposed for about a fortnight and root-pruned to a certain extent.

Manurial experiment.—Manure is generally applied to the fig at the end of the weathering period. The addition of lime or old mortar is said to be of great effect. The green manure will be dug in at the time of weathering.

Cultivation experiment.—The effect of cultivation is said to be considerable from March to May during the ripening of the fruit.

Irrigation experiment.—As the fruit ripens during the hot weather, the effect of irrigation should be considerable.

BANANAS.

As the supply of suckers is at present insufficient, the banana plot has not yet been planted out. A space sufficient for six varieties in single rows has been left between the figs and the eastern peach plot, and it is expected that this area will be laid out next July. The details will be given in the next report.

The land reserved for banana experiments slopes towards the south and west so that irrigation will be easy. The soil is a strong loam and appears a likely one for this crop.

Four of the best Bengal varieties and the best two sorts from Bassein have been selected for these experiments.

Plan of Eastern Peach Plot.

20' in rows, 25' between rows.

NORTH.

1

| | | | | | | | |
|-------|----|---|---|---|-------------------------|--------------------------|--|
| WEST. | 30 | x | x | x | End trees. | | |
| | 29 | x | x | x | Grafted on plum | | |
| | 28 | x | x | x | stocks. | | |
| | 27 | x | x | x | Budded on plum | | |
| | 26 | x | x | x | stocks. | Stock experiment. | |
| | 25 | x | x | x | Seedling peach | | |
| | 24 | x | x | x | stock. | | |
| | 23 | x | x | x | Soil trenched 2' deep. | | |
| | 22 | x | x | x | | | |
| | 21 | x | x | x | | | |
| | 20 | x | x | x | Soil dug. | Planting experiment. | |
| | 19 | x | x | x | | | |
| | 18 | x | x | x | | | |
| | 17 | x | x | x | Planted in holes. | | |
| | 16 | x | x | x | | | |
| | 15 | x | x | x | | | |
| | 14 | x | x | x | Pruned every year. | Pruning experiment. | |
| | 13 | x | x | x | | | |
| | 12 | x | x | x | | | |
| | 11 | x | x | x | No pruning. | | |
| | 10 | x | x | x | | | |
| | 9 | x | x | x | | | |
| | 8 | x | x | x | No root-pruning. | Root-pruning experiment. | |
| | 7 | x | x | x | | | |
| | 6 | x | x | x | | | |
| | 5 | x | x | x | Root-pruned every year. | | |
| | 4 | x | x | x | | | |
| | 3 | x | x | x | | | |
| | 2 | x | x | x | End trees. | | |
| | 1 | x | x | x | | | |

Country No. 1. Hakim. Houey.
SOUTH.

EASTERN PEACH PLOT.

The experiments in this plot are a continuation of those in the western peach plot. They deal with the effect of (1) root-pruning, (2) branch pruning, (3) different methods of planting, and (4) the effect of different stocks, on the development of peach trees. The soil in these experiments is distinctly heavier and more clayey than that of the other peach plot, but the land slopes to the south so that drainage during the monsoon is an easy matter.

Varieties.—Three varieties of budded or grafted peaches—Country No. 1, Honey and Hakim—were obtained from the Botanic Gardens, Saharapur, for these experiments.

Preparation of the land and planting.—The initial preparation of the soil for the plants varies in the various experiments and is described in detail below. Several of the trees in this plot were killed by ringing, as the labels were by an oversight left on some of these trees at planting time. Although a vigorously growing tree, the peach is extremely sensitive and readily succumbs to injuries.

Root-pruning experiment. It appears probable that weathering the trees after the rains will not be sufficient at Pusa to check the vegetative vigour of the trees and that root-pruning as well will be necessary. Further, the operation may be of use in reducing the amount of the annual pruning and so producing a more manageable tree. Accordingly this experiment has been arranged to throw light on this point. The trees were planted on March 6th, 1906, in holes six feet in diameter and three feet deep. The pits were half filled, the loose soil moderately compacted and the remainder mixed with three baskets of *sarkhi* and one of rape cake before filling in. Watering during the hot weather was done by means of sunk pots.

Pruning experiment.—As the peach bears on the lower two-thirds of the shoots of the previous year's wood, it is usual to shorten these branches by a quarter to a third of their length during the resting period at the end of the year. The shoots in the centre of the trees, and those which would be shaded by branches above, should also be removed. A plot pruned in this manner will be compared with one in which there is no pruning except that which

the trees do themselves. The method of planting in this plot was the same as that adopted in the root-pruning experiment.

Planting experiment.—In order to find out whether the preliminary preparation of the soil has any effect on the growth of peach trees, three plots were arranged in a similar manner to those in the western citrus plot. One set of trees was planted in holes, another in soil which had been dug, and a third set in soil which had been trenched to a depth of two feet. The trees were planted in March, 1906, and manured and watered in a similar manner to those in the pruning experiments above. As the peach is deciduous, it will be possible to lift trees from these plots without injury and compare the development of the root systems.

Stock experiment.—It would be an advantage in Behar if some stock other than the seedling peach could be used. There are three disadvantages to the use of these stocks: (1) the vegetative vigour of the tree is too great, (2) a considerable amount of annual pruning is necessary, and (3) they only thrive on open soils with a freely draining subsoil and where there is no danger of water-logging. Possibly the use of plum stocks would be an advantage in checking growth, and it is likely that these stocks would grow better than peaches in the stiffer soils. If so, the range of the peach could be greatly extended. In the experiment in question, the behaviour of the same varieties of peaches will be compared when grown on seedling peach and plum stocks. The trees were planted at the end of August, 1906, in soil which had been worked with barrows. No manure was used at planting time, but sun hemp was sown between the rows and ploughed in September, 1906.

Eastern and Western Borders.

Eastern Border.—On the east side of the experimental area a row of grafted Sapodillas was planted in March, 1906, twenty feet apart. These occupy the land between the eastern peach plot and the wind-break.

Western Border.—There is a double row of plants in this border. Next to the western citrus plot a row of pomegranates was planted twelve feet apart in March, 1906. The trees were obtained from Poona, Bangalore and Saharanpur, and are seedlings and grafts of various varieties.

Between the pomegranates and the wind-break a row of mixed fruit trees was planted at the beginning of the hot season of 1906. The composition of this row is given in the following table:

| Variety. | Kind of plant. | Received from | | |
|---|----------------------|------------------------------|---|---|
| Apple (<i>Pyrus malus</i>) | Grafts and cuttings. | Bangalore Botanical Gardens. | | |
| Karamb (<i>Carissa carandas</i>) | Seedlings | Saharanpur | " | " |
| Paniyala (<i>Flacourtia cataphracta</i>) | " | " | " | " |
| Natal plum (<i>Adiantum bispinosa</i>) | " | " | " | " |
| Mulberry, large black (<i>Morus nigra</i>). | Cutting | " | " | " |
| Wampee (<i>Otaseena wampee</i>) | Seedling | " | " | " |
| Kamraki (<i>Acerbat carambola</i>) | " | " | " | " |
| Elephant apple (<i>Feronia elephantina</i>). | " | " | " | " |
| Bev (<i>Zizyphus jujuba</i>) | Budded and seedling. | " | " | " |
| American Persimmon (<i>Diospyros virginiana</i>). | Seedling | " | " | " |
| Persimmon (<i>Diospyros kaki</i>) | Seedling and graft. | " | " | " |
| Monkey fruit (<i>Artocarpus lakucha</i>). | Seedling | " | " | " |
| Jamun (<i>Eugenia jambolana</i>) | " | " | " | " |
| Star Gooseberry (<i>Phyllanthus distichus</i>). | " | Empress Garden, Poona. | | |
| Barbados cherry (<i>Malpighia glabra</i>). | " | " | " | " |
| Bael (<i>Ale marmelos</i>) | " | " | " | " |
| Belgaum walnut (<i>Alcarites moluccana</i>). | " | " | " | " |
| Rose apple (<i>Eugenia jambos</i>) | " | " | " | " |
| Cucumber tree (<i>Acerbat Bilimbi</i>) | " | Calcutta Botanical Gardens. | | |
| Avocado pear (<i>Persea gratissima</i>) | " | " | " | " |
| Sapodilla (<i>Achras sapota</i>) | Graft | Hort. Soc., Calcutta. | " | " |
| Jack fruit (<i>Artocarpus integrifolia</i>). | Seedling | Pusa. | " | " |

FRUIT VARIETIES.

A collection of varieties of fruit trees has been made at Pusa. The object of this is to have at hand material for future work on the improvement of Indian fruits by selection and hybridisation, and also to determine which varieties are most suitable for Behar. The following lists show the composition of the variety plot:—

1. Peaches.

All the varieties are budded on seedling peach stocks.

| Name. | Obtained from |
|---------------------------------|--------------------------------|
| Maicha | Botanical Gardens, Saharanpur. |
| Peshawar | " " " |
| Paragon Slipstone | " " " |
| Anderson's Spring Hill? | " " " |
| Beaulot's Slipstone | " " " |
| Bidwell's early | " " " |
| Barrington | " " " |
| Flat China | " " " |
| Country No. 1 | " " " |
| " " 2 | " " " |
| " " 3 | " " " |
| " " 4 | " " " |
| Double Flowering | " " " |
| Elcock's Slipstone | " " " |
| Honey | " " " |
| Sulani | Indian dealer, Calcutta. |
| Enju | " " " |
| Countess | Botanical Gardens, Saharanpur |
| Violet Native | " " " |
| Florida's own | " " " |
| Early Cream | " " " |
| Gibber's Indian | " " " |
| Flapton | " " " |
| Red Ceylon | " " " |
| Large Agra | " " " |

2. Citrus Fruits.

The citrus plants are as a rule budded. Where only seedlings could be obtained these are indicated below by the letter "S" in brackets.

A. Oranges --

| Name. | Obtained from | | |
|----------------------------|---------------------------------|-----|-----|
| Mozambique | Empress Gardens, Poona. | | |
| Silver | Horticultural Gardens, Lucknow. | | |
| Srinagar (S) | Botanical Gardens, Saharanpur. | | |
| Butwal (S) | " " | " " | " " |
| Kaula | " " | " " | " " |
| Whitaker | " " | " " | " " |
| Common Santra | " " | " " | " " |
| Malta | " " | " " | " " |
| Vanille | " " | " " | " " |
| Malta Blood | " " | " " | " " |
| DeCalbre | " " | " " | " " |
| De la Societ  | " " | " " | " " |
| Mandarin | " " | " " | " " |
| Sz-in-kau | " " | " " | " " |
| St. Michael's | Horticultural Garden, Lucknow. | | |
| Sylhet | Botanical Gardens, Saharanpur. | | |
| Sour Florida (S) | Horticultural Gardens, Lucknow. | | |
| Nagpur | Cultivator's Garden, Nagpur. | | |
| Ladoo | Empress Gardens, Poona. | | |

B. Pumelos--

| | |
|-------------------------------|---------------------------------|
| Large red fleshed | Botanical Gardens, Saharanpur. |
| Large white fleshed | " " " |
| Seedling (S) | Empress Gardens, Poona. |
| Small oval | Horticultural Gardens, Lucknow. |

C. Citrons--

| | |
|------------------------|--------------------------------|
| Turunj (S) | Botanical Gardens, Saharanpur. |
| Finger (S) | " " " |
| Seedling (S) | Empress Gardens, Poona. |

D. Lemons--

| | |
|----------------------------------|---------------------------------|
| Imperial | Horticultural Gardens, Lucknow. |
| No. 5 | " " " |
| Edratin de Calabre (S) | Botanical Gardens, Saharanpur. |
| Italian (S) | " " " |
| Bijori (S) | " " " |

E. Limes—

| Name. | Obtained from | | | |
|------------------|---------------|---|---|--------------------------------|
| Kaghzi (S) | . | . | . | Botanical Gardens, Saharanpur. |
| Gulgal (S) | . | . | . | " " " |
| Desi Kalamba (S) | . | . | . | " " " |
| Sour Lime (S) | . | . | . | Empress Gardens, Poona. |
| Sylhet (S) | . | . | . | Botanical Gardens, Saharanpur. |
| Sweet Chikna (S) | . | . | . | " " " |
| Khatta (S) | . | . | . | " " " |
| Jamberi (S) | . | . | . | " " " |
| At Anni (S) | . | . | . | " " " |
| Amilbaid (S) | . | . | . | " " " |

3. Mangos.

All the mangos are grafted on seedling stocks.

| | | | | |
|-----------------|---|---|---|----------------------------------|
| Twelve month | . | . | . | Indian dealer, Calcutta. |
| Twice flowering | . | . | . | " " " |
| Fazli | . | . | . | " " " |
| Gopal Washerman | . | . | . | " " " |
| Laogra | . | . | . | " " " |
| Bhut Bombay | . | . | . | " " " |
| Bombay Yellow | . | . | . | Botanical Gardens, Saharanpur. |
| Alphonso | . | . | . | Empress Gardens, Poona. |
| Nawab Bhog | . | . | . | Indian dealer, Calcutta. |
| Brijanath Dhar | . | . | . | " " " |
| Kumarajali | . | . | . | " " " |
| Borsha | . | . | . | Empress Gardens, Poona. |
| Pot | . | . | . | " " " |
| White Cluster | . | . | . | " " " |
| Godhadi Pairie | . | . | . | " " " |
| Kutna | . | . | . | Botanical Gardens, Saharanpur. |
| Najibabadi Amin | . | . | . | " " " |
| Punia | . | . | . | " " " |
| Hatijhal | . | . | . | " " " |
| Madras | . | . | . | " " " |
| Pyassi | . | . | . | " " " |
| Naijab | . | . | . | " " " |
| Stalkart | . | . | . | " " " |
| Miss Harwood's | . | . | . | Horticultural Society, Calcutta. |
| Madras | . | . | . | " " " |
| Ennuriva | . | . | . | " " " |
| Kaput-Bhunjia | . | . | . | " " " |
| Gopal Bhog | . | . | . | " " " |

3. Mangos—*contd.*

All the mangos are grafted on seedling stocks.

| Name. | Obtained from |
|--------------------------|----------------------------------|
| Bhadaya | Horticultural Society, Calcutta. |
| Bhurdas | Botanical Gardens, Saharanpur. |
| Bulbulchashni | " " " |
| Faqirwala | " " " |
| Gola | " " " |
| Nueka | " " " |
| Sanduria | " " " |
| Tamancha | " " " |
| Calcutta Amin | " " " |
| Romani | " " " |
| Safala | " " " |
| Kueha Mittha | " " " |
| Langra | " " " |
| Sherbati Brown | " " " |
| Bhadamra | " " " |
| Sarkas | " " " |
| Sunahra | " " " |
| Malda | " " Calcutta. |

4. Litchis.

All the litchi plants are layers.

| | |
|---------------------------|------------------------------------|
| McLenn's | Horticultural Society, Calcutta. |
| Muzaffarpore | Cultivator's Garden, Muzaffarpore. |
| Bedana | " " Calcutta. |
| China Bombay | " " " |
| Patiuria Bombay | " " " |
| Bangalore | Lal Bagh, Bangalore. |
| Hak-yis | Horticultural Society, Calcutta. |
| Green | Native Garden, Muzaffarpore. |
| Chinese | " " " |

5. Plums.

Most of the plums were raised from cuttings.

| | |
|------------------------------|--------------------------------|
| Dwarf Early Yellow | Botanical Gardens, Saharanpur. |
| Early Large Red | " " " |
| Early round | " " " |
| Alucha Purple | " " " |
| Alucha Red | " " " |
| Alucha Yellow | " " " |
| Alucha Black | " " " |

5. Plums—*contd.*

Most of the plums were raised from cuttings.

| Name. | Obtained from |
|-----------------------------|--------------------------------|
| Alusha large | Cultivator's Garden, Calcutta. |
| Alubukhara | Botanical Garden, Saharanpur. |
| Alubukhara | Cultivator's Garden, Calcutta. |
| Large Red | " " " |
| Large Yellow | " " " |
| Bangalore variety | Lal Bagh, Bangalore. |
| Alubukhara small | Botanical Gardens, Saharanpur. |
| Kabul Green | " " " |

6. Guavas,

Most of the guavas are seedlings.

| | |
|-----------------------------|--------------------------------|
| Allahabad | Botanical Garden, Lahore. |
| Bombay | Cultivator's Garden, Calcutta. |
| Bangalore (graft) | Lal Bagh, Bangalore. |
| " (seedling) | " " " |
| China | Native dealer, Calcutta. |
| Kashi (Benares) | " " " |
| Kafri | " " " |
| Red fleshed | Botanical Gardens, Saharanpur. |
| Karaila | " " " |
| Cattley's | " " " |
| Smooth Green | " " " |

